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ENVIRONMENTAL COST ENGINEERING BULLETIN

UNITED STATES ARMY CORPS OF ENGINEERS

District Cost Engineering Capabilities for Hazardous, Toxic, and Radioactive Waste (HTRW) Projects

1. Purpose. This bulletin describes the U.S. Army Corps of Engineers (USACE) Cost Engineering capabilities within the Corps to perform services to develop HTRW project cost estimates and other cost engineering support activities from the programming/budgeting phase to final closeout.

2. Introduction. The HQUSACE Cost & Economic Team and the HTRW Center of Expertise (CX) have developed a number of resources to assist district cost engineering personnel to more effectively estimate HTRW Remedial Action (RA) and Operation and Maintenance (O&M) project costs, and to support the entire HTRW project team. This bulletin addresses (1) USACE cost engineering policy; (2) the complexity of estimating the cost of HTRW projects; (3) cost engineering capabilities; (4) cost engineering software programs, databases, and documents; and (5) cost engineering training to enhance the capabilities of cost estimators and other engineering staff elements.

3. Policy. ER 1110-3-1301 establishes the Cost Engineering office as a member of the project team. ER 1110-3-1301 clearly establishes the Cost Engineering office as having the responsibility for development and/or review of RA and O&M cost estimates for HTRW projects. This includes applicable RA and O&M costs for each phase of the project such as Preliminary Assessment/Site Inspection (PA/SI), Remedial Investigation/Feasibility Study (RI/FS), Record of Decision (ROD), or Remedial Design (RD). This includes life cycle cost estimates for competing technologies and alternatives during the RI/FS phase, and development of RA and O&M estimates during the RD phase or earlier.

4. Developing HTRW Cost Estimates.

a. HTRW projects differ from more traditional projects because they must comply with complex environmental laws that require Federal, state, and public coordination involvement. Therefore, development of an HTRW cost estimate for environmental restoration projects is often more complex and more involved. For example, development of a construction cost estimate for a conventional building, such as an office building, is relatively straightforward in comparison to development of a remedial action cost estimate to clean up hazardous and/or radioactive waste. For a conventional project, dimensions can generally be defined with a good measure of precision, quantities of construction materials are readily calculated from design drawings, and materials are normally available from a number of local suppliers. Labor is also generally available locally, and worker production rates are well documented. Experience shows that there is likely to be little cost growth due to unknown conditions.

b. In comparison, the scope and cost of an HTRW project are largely determined by what is in the ground. Because of the migratory nature of contamination, it is costly and time consuming to determine the full extent of contamination before initiating work. In a heterogeneous subsurface environment, interpolations between data points need to be continually made to try to define the estimated type and extent of contamination. Therefore, quantities of contaminated groundwater or contaminated soil are difficult to determine, and additional types of contaminants may be found during the remedial action activities. Thus, the chance of variations in materials and quantities for RA projects is high.

c. Additionally, the time it takes to begin and complete an HTRW project is often lengthy due to the time required to characterize a site (identify type and extent of contamination), optimize efficiency of the treatment process, and keep the public continually informed of cleanup efforts. All of these factors add time and resources to an HTRW project. Wearing of personal protective equipment can also have a significant impact on worker production rates. As a result, direct HTRW RA costs are more difficult to calculate with certainty for both competing contractors and the Government. Indirect costs for HTRW projects are also typically higher than those for conventional construction and contractors must also include larger reserves for the higher risk they have to assume on HTRW projects. All of these factors result in comparatively higher costs for HTRW projects, and the potential for significant cost growth during RA.

5. Cost Engineering Capabilities. USACE Cost engineering offices responsible for developing HTRW cost estimates can generally provide the following services. Individual districts should be contacted to obtain specific capabilities.

- Develop RA and O&M cost estimates from programming/budgeting phase to final project closeout;
- Obtain and develop pre-remedial action (non-construction) costs such as cost estimates to prepare study activities and documents;
- Develop Life Cycle cost estimates for comparing alternatives;
- Review all contractor prepared or in-house HTRW cost estimates at all project phases;
- Develop cost estimates for RA modifications/change orders and assist in negotiations;
- Make comparative analysis of contractor's proposals and assist in negotiations;
- Provide technical cost support as a primary basis for development of project schedules;
- Provide cost engineering assistance on reimbursable cost contracts to control contractors costs;
- Provide cost input to designers on HTRW innovative technologies;
- Track and record 'real time' costs for field activities during construction phases;
- Develop contingencies for HTRW projects for any project phase;
- Collect and analyze HTRW historical cost data.
- Develop Cost to Complete estimates for all applicable project phases.

6. Cost Engineering Resources for Developing HTRW Cost Estimates. The Cost Engineering offices at each district have cost estimating software, databases, and documents available to use in developing HTRW RA and O&M cost estimates at various project phases. Each of them are described below:

a. **HTRW Remedial Action (RA) and Operation and Maintenance (O&M) Work Breakdown Structures (WBS):** Both the RA WBS and O&M WBS are hierarchical breakdowns of work tasks in a numbered structure, organized in a logical construction sequence. Both structures provide a uniform standard to organize and report RA and O&M work to be performed in accomplishing an HTRW project. The primary purposes of the structures are to (1) collect HTRW RA and O&M cost data in a standard format for cost reporting and tracking using the Project Management Information System (PROMIS); and, (2) to report, aggregate, and disseminate historical cost data in a standard format using the Historical Cost Analysis System (HCAS). The WBSs thus facilitate communication between management and technical disciplines concerning project elements during all project phases. Tracking and reconciliation of estimates between project phases is also accomplished more easily because of consistency of structure. A data dictionary, indicating what is included in each task clarifies interpretation of the tasks for both WBSs. The HTRW RA and O&M WBS is located at: **http://www.environmental.usace.army.mil/info/technical/cost/costtool/costtool.html**.

b. **Micro Computer-Aided Cost Engineering System (MCACES) Databases with HTRW Specific Items:** MCACES is available in both DOS and Windows. MCACES is the standard cost estimating system used by all district Cost Engineering offices. It is a detailed cost estimating program, which is utilized primarily for development of cost estimates where detailed design information is available. MCACES is a proven system and has been used by the Corps to estimate the cost of military, civil works, and HTRW projects. A number of enhancements have been have been made to improve the use of MCACES for estimating HTRW projects. For example, MCACES includes a Unit Price Book (UPB) database that contains cost information on more than 21,000 unit price line items for construction labor, equipment, and material. Approximately 4,000 of these items are HTRW and Radioactive items, which reflect costs for personal protective equipment, drum overpackings, treatment technologies, etc. In addition, a host of HTRW models and assemblies have been developed for MCACES that can be used to prepare remedial action cost estimates. The use of models and assemblies has several advantages including predefined tasks, standardization using the Remedial Action Work Breakdown Structure (RA WBS), and applicability when detailed design is not completed. Some of the technologies for which cost models and assemblies have been developed include bioremediation, air stripping, landfarming, carbon adsorption, slurry walls, stabilization, etc. MCACES provides the most flexibility in parametric estimating.

c. **RA Cost Contingency Analysis:** Contingencies include RA costs of unknowns, unforeseen uncertainties, and/or unanticipated conditions that are not possible to adequately evaluate from the data on hand at the time a cost estimate is prepared, but must be represented by a sufficient cost to cover the identified risks. Contingencies are normally separated into two elements for incremental analysis - design contingencies and construction contingencies.

- Design contingencies include estimated RA cost increases due to design incompleteness, detail changes, alternative design changes, and associated pricing inaccuracy. The extent of site characterization and assessment that has

been accomplished to compute project quantities must be considered when determining design contingencies for HTRW construction costs. For example, estimates of groundwater volume and concentration are often possible only after field pump tests are completed. Many feasibility studies are prepared before these tests and so must rely on assumed volumes and concentrations. Design contingencies will normally decrease, as design information becomes known.

- Construction contingencies are a reserve for RA cost growth due to adverse or unexpected conditions such as unforeseeable relocations, foundation conditions, utility lines in unknown locations, quantity overruns, or other unforeseen problems beyond interpretation at the time of or after contract award.

One of the most important tasks in estimating the cost of RA projects is predicting contingencies that will cover all the uncertainties associated with the nature and extent of the contamination and the design and effectiveness of the remedy being used. The project managers and cost engineers must be aware of the cost risk in RA projects and manage it by allowing for contingencies commensurate with the level of cost risk.

The Corps is in the final stages of developing a computer-based analysis software called CostRisk, which is a windows-based program that analyzes a project and predicts cost contingencies. CostRisk is a risk analysis program using Monte Carlo simulation on risky cost elements that have a high degree of uncertainty. CostRisk is used to determine the amount of contingency needed to provide a certain amount of confidence level and thus, reduce risk of budgetary estimate overrun.

d. **Historical Cost Analysis System (HCAS):** HCAS is a database of historical HTRW project and cost information categorized by the HTRW WBS. The database facilitates storage, management, and retrieval of cost, site description, project administration, and technological information. HCAS provides essential information for designers, cost engineers, and program managers. HCAS does not produce cost estimates, but is used by the Cost Engineering office to obtain historical remedial action cost information for comparison or programming purposes. The current database contains award costs for over 80 remedial action projects mostly from the Corps but also from other agencies. Remedial action costs are collected and grouped in HCAS primarily by the HTRW RA WBS. HCAS can be downloaded using the HCAS link from: **http://www.environmental.usace.army.mil/info/technical/cost/cost.html.**

e. **Remedial Action Cost Engineering and Requirements (RACER) System:** RACER was designed by the Air Force to assist in the development and evaluation of alternatives for remediation, and to estimate costs of HTRW and OE (Ordnance and Explosive) projects. The RACER system uses parametric models of cleanup systems to develop costs for HTRW remediation at all phases from characterization through final closeout. RACER uses generic cost models based on historical HTRW and OE projects and technologies. The generic models available in RACER are modified to reflect actual conditions of new projects. The tailored models are then quantified and priced in accordance with the current costing data contained within the current ECHOS database. RACER will estimate costs for studies, design, remedial action, and operation and maintenance. Over 100 generic cost models have been developed to date. The RACER software is available for Government use at no cost.

f. **HTRW Productivity Study:** Worker productivity is one of the most variable cost elements in a RA project. The HTRW CX developed a productivity study for HTRW projects by observing remedial action work in progress, reviewing construction progress records, performing a literature search, and conducting face-to-face interviews with remedial action contractors and Corps field personnel. The study documents the dramatic impact that worker protection level requirements have on construction production rates. Variables that affect production include work intensity, personal protective equipment requirements, temperature, meetings, suiting up/off, air tank/filter changes, personal decontamination, monitoring delays, breaks, cleanup, and dexterity. Two tables were developed identifying HTRW productivity factors for both light work and heavy work. The tables provide factors for each OSHA protection level, i.e., A, B, C, D+, and D. For example, if a person is performing heavy work, i.e., hand excavation, in 80-degree weather, and is in Level B protection, their productivity factor from the table is .36. In other words, if they could excavate one cubic yard per hour under normal conditions in street clothes, they could only excavate .36 cubic yards per hour under this scenario. The results of the study were distributed to all districts as the "Productivity Study for HTRW RA Projects", dated October 1994, and is available at **http://www.environmental.usace.army.mil/info/technical/cost/costprod/costprod.html.**

g. **Treatment, Storage, and Disposal Facilities (TSDF) Report:** The TSDF report was updated and distributed in April 1998 to each Cost Engineering office and Construction Division at each USACE division and district. This report identifies all known commercial hazardous waste treatment, storage, and disposal facilities in the United States. The report includes charges identified by each facility for items such as disposal of various types of waste, state taxes and fees imposed on the disposal of hazardous waste, points of contact with telephone numbers for each facility, and transportation costs for hazardous waste. The report also identifies what the treatment capabilities and restrictions are for each facility. The report can be found at **http://www.environmental.usace.army.mil/library/pubs/tsdf/tsdf.html.**

h. **Engineer Instructions (EI) 01D010- "Construction Cost Estimates":** This is a Corps of Engineers "how to" manual to prepare construction cost estimates for all programs, Military, Civil Works, and HTRW. The manual provides the cost engineer with the necessary HTRW unique requirements and features to prepare an HTRW RA cost estimate. The manual is currently being converted to a Technical Instruction (TI) manual, TI 802-02. It will be available on the web site, **http://www.hnd.usace.army.mil/techinfo/ti.htm** once it is completed.

i. **A Guide to Developing and Documenting Remedial Alternative Cost Backup Estimates during the Feasibility Study:** This is an update of an early US Environmental Protection Agency (USEPA) guidance document that addresses the expectations for cost estimates of remedial action alternatives developed as part of the Remedial Investigation/Feasibility Study (RI/FS) process. The USEPA and the US Army Corps of Engineers (USACE) completed it, in July 2000. These cost estimates are then used in the Superfund remedy selection process upon completion of the RI/FS. The goals of this update effort include the following:

1) Encourage the development of more complete and accurate cost estimates by identifying resources for cost estimating;
2) Improve the consistency of cost estimates by presenting clear procedures and expectations; and

3) Improve the documentation of cost estimates by presenting a standard format and checklist of cost elements.

The targeted audiences for this guidance include cost estimators, technical support contractors, remedial project managers (RPMs), and program managers. This guidance is intended to satisfy the needs of each of these audiences. It should provide the cost estimator and technical support contracting community with a resource to help them develop better cost estimates utilizing consistent procedures. It should provide RPMs and program managers with an understanding of the nature of the cost estimates that are presented to them and the questions they need to ask when reviewing and evaluating them. The guidance document can be downloaded from the Headquarters USACE Cost Engineering web page at **http://www.hq.usace.army.mil/cemp/e/ec/ec-regs.htm#anchorER** (scroll down to "Environmental Cost Estimating Guide") or at the USEPA web page at **http://www.epa.gov/superfund/resources/remedy/costest.htm.**

j. **EPA & USACE "Guide to Preparing and Reviewing Remedial Action (RA) Reports of Cost and Performance":** This guide contains an EPA version and a Corps version. The EPA Version was furnished to HQEPA in March 2001, and the Corps version is an Engineer Pamphlet, EP 1110-1-19, dated June 2001. The RA Report is prepared following completion of the RA phase of a project. The goals of the RA Report include:

1) To Confirm that the remedy outlined in the ROD has been fully implemented;
2) To Confirm that cleanup goals have been achieved;
3) To document key observations and lessons learned;
4) To summarize technology performance data; and,
5) To provide historic costs in HTRW RA and O&M WBS format for HCAS entry.

The document can be downloaded from:
http://www.usace.army.mil/inet/usace-docs/eng-pamphlets/ep1110-1-19/toc.htm.

k. **HTRW Center of Expertise (CX):** Centers of expertise are designated USACE organizations or individuals who have demonstrated capability and expertise in a specialized area. They improve capabilities and management, eliminate redundancy, and optimize the use of specialized expertise and resources. They also enhance Corps-wide consistency, facilitate technology transfer, help maintain institutional knowledge in key areas, and improve service to the customer. For more information on the HTRW CX, contact the home page at **http://www.environmental.usace.army.mil/**

7. Training. The HTRW Center of Expertise, in conjunction with HQUSACE and Huntsville Engineering and Support Center offer a variety of HTRW courses and workshops which will enhance the capabilities for HTRW Cost Engineering and other engineering staff elements. The following courses specifically address cost engineering:

a. Environmental Restoration Overview Course (PROSPECT) - This course summarizes USACE HTRW programs such as Superfund, Defense Environmental Restoration program (i.e. Installation Restoration, Formerly Used Defense Sites) Base Realignment and Closure (BRAC), and support for others programs. The course addresses the Corps' HTRW organizational structure, HTRW project execution and management, contracting strategies, applicable environmental laws and regulations, community relations, ordnance and explosive wastes, risk assessment, health and

safety, site characterization, environmental monitoring, cost engineering, UST projects, geotechnical and treatment design technologies, and lessons learned.

b. Other HTRW PROSPECT Courses. Other prospect courses available for Cost Engineering and other engineering staff elements include but are not limited to the following:

- Cost Estimating Basics
- HTRW Construction Inspection
- Environmental Laws and Regulations
- Hazardous Waste Management and Manifesting/DOT Certification
- Radioactive Waste Transportation
- HTRW/Construction Cost-Reimbursement Contract Task Order
- CERCLA/RCRA Process
- TERC Task Order Administration
- Negotiating Construction Contract Modifications
- Soil Vapor Extraction and Bioventing Workshop
- Value Engineering

c. MCACES training is a cost estimating software specific course. MCACES is a detailed estimating system used primarily when design details are developed. Training is available through the Huntsville TRACES team (256) 895-1833.

d. RACER training is another software specific course. RACER is a parametric estimating system used in the development of HTRW cost estimates, particularly during preliminary or budget stages. Training is available through both the HTRW CX and Earth Tech/Talisman Partners, Ltd.

e. The HTRW Center of Expertise also conducts several other workshops listed below:

- Process Engineers Workshop
- Innovative Technology Workshop
- Technical Project Planning Workshop

The training opportunities presented above are not intended to be all inclusive, but represent a number of courses that will assist in understanding and developing HTRW project cost estimates. The HTRW CX continues to support development of new courses and workshops to meet the changing demands of HTRW restoration. Please contact the HTRW CX to discuss the courses that are presently available to meet your needs.

8. Looking Ahead. USACE is continuing to work with other agencies to develop and improve HTRW cost estimating standards, cost programs, and to collect and share data. Some specific initiatives now in progress include the following:

a. **MCACES MII.** MCACES MII is being developed in a 32-bit Windows environment, and is scheduled to be completed in FY2002.

b. **HTRW Area Cost Factors.** A study was completed including development of HTRW Area Cost Factors for Department of Energy (DOE) sites in September 2001. The HTRW Area Cost Factors will be used for localizing historical HTRW cost data.

c. **Independent Government Cost Estimate (IGCE) Guidance.** This guidance for EPA is being developed by the HTRW CX and is scheduled for completion in FY 2002. Estimating spreadsheets with Level of Effort Labor Tables will also be developed concurrently for EPA use. These spreadsheets are for estimating non-construction tasks such as remedial investigations, studies, designs, and project management.

d. **RACER.** RACER is annually being updated to improve existing and add new features and models for estimating HTRW projects more accurately. New features allow for maximum flexibility within RACER's parametric framework to develop future cost estimates.

e. **TSDF Report.** The TSDF report was last distributed in March 1998, and is currently being updated in 2002.

9. Summary. USACE Cost Engineering offices have the resources and capabilities to effectively develop all costs associated with HTRW projects. Developing complete RA and O&M cost estimates from programming to final close out will enable our customers to more effectively manage costs on their HTRW project to completion.

10. Points of Contact

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